# KEELOQ® EVALUATION KIT USER'S GUIDE

# KEELOQ® Evaluation Kit User's Guide

# Table of Contents



# Chapter 1. About the KEELOQ Evaluation Kit

## 1.1 Introduction

The KEELOQ® Evaluation Kit is designed to give the potential user the opportunity to evaluate KEELOQ code hopping technology quickly and easily without having to make a large capital investment. The evaluation kit contains all the hardware and software necessary to implement a fully functional remote control system and demonstrate all of the operating modes of the HCS200, HCS201, HCS300, HCS301, HCS320, HCS360, and HCS361 encoders and the MCSLRN, MCSIMDEC, MCDEC, and HCS512 decoders.

The software included can be used to program the demonstration transmitters and the DIP samples provided in the sample kit. The software is Windows®-based. Encryption keys, configuration information, and other user selectable information are automatically programmed into the encoder's EEPROM. Although many interdependent parameters have to be taken into account when programming the encoder and decoder combination, the process is automated and transparent to the user.

## 1.2 Evaluation Kit Contents

The KEELOQ Evaluation Kit contains the following hardware, software, and user guides:

- Decoder Demonstration Board
- HCS Device Programmer
- Evaluation Kit Diskette (setup.exe)
- User's Guide
- Power Supply
- RS-232 Cable
- 16-way Ribbon Cable
- Sample Kit containing KEELOQ samples

Also included in the KEELOQ Evaluation Kit are the following Data Sheets

- HCS200 Data Sheet
- HCS201 Data Sheet
- HCS300 Data Sheet
- HCS301 Data Sheet
- HCS320 Data Sheet
- HCS360 Data Sheet
- HCS361 Data Sheet
- HCS512 Data Sheet
- Application Notes describing the software decoders

**NOTES:**

# Chapter 2. Installing and Running KEELOQ Evaluation Kit

## 2.1 Installation

The software on the disk provided is Windows-based software. The KEELOQ software can be installed in the default directory C:\HCS_EVAL or in another directory.

1. Insert the KEELOQ installation disk into drive A.
2. If you are using Windows® 3.1 from the Program Manager *File > Run* command, type **A:Setup**. If you are using Windows 95, 98 or Windows NT 4.0, click on the **Start** button, select Run, and type **A:Setup**. The Setup screen opens with options to **OK** or **Cancel**.
3. Clicking **OK** to display the "Select Destination" dialog box with options **OK** or **Cancel**.

   Click **Cancel** to abort the installation.
4. Click **OK** after selecting a directory where the software is to be installed.

   Click **Cancel** to abort the installation.
5. The "Make Backups?" dialog box opens with the options **Yes**, **No**, **Cancel**.
6. Click **Yes** to backup files being replaced.

   Click **No** to overwrite files.

   Click **Cancel** to abort the installation.
7. If **Yes** was selected in the previous step the "The Select Backup Directory" dialog box opens with options **OK** and **Cancel**.
8. Click **OK** after selecting a directory where backups will be made.

   Click **Cancel** to abort the installation.
9. After the files have been installed, the "Install Icons" dialog box opens with options **Yes**, **No**, **Cancel**.

   Click **Yes** to add the software Icons.

   Click **No** to skip adding the Icons.

   Click **Cancel** to abort installation.
10. If **Yes** was selected in the previous step, the "Select Program Manager Group" dialog box with options **OK** and **Cancel** is displayed.
11. Click **OK** after selecting the group where the Icons will be installed.

    Click **Cancel** to abort installation.
12. After the software has been installed, a "Setup Complete" message will appear.

## 2.2 Serial Port Selection

The KEELOQ software uses a serial port to communicate with the programmer board. The default serial port used is COM1. The active serial port can be changed in the "Com Port" dialog box (Figure 2.1). The dialog box can be displayed by selecting "Com Port" from the "Setup" menu.

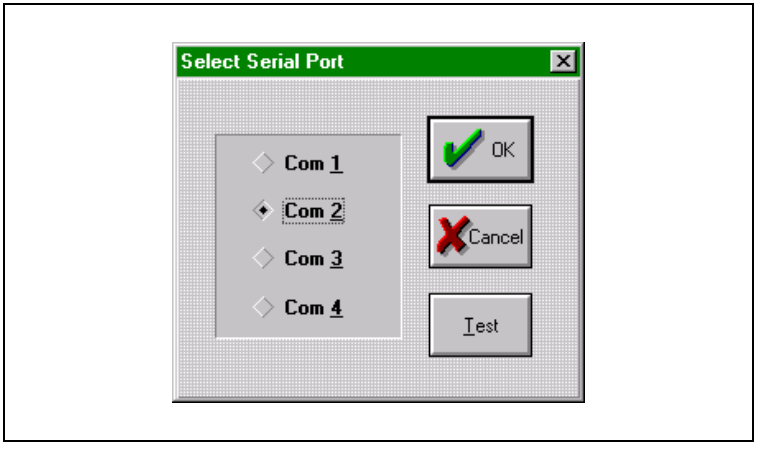



**Figure 2.1: Serial Port Selection Dialog Box**

To test the serial port selected, connect the programmer board to the appropriate COM port, connect the power, and press the Test button. The software will display a message to tell the user whether the programmer has been found or not.

# Chapter 3. KEELOQ Encoders

## 3.1 General Description

The Microchip KEELOQ range of encoders are code hopping remote control encoders intended for secure remote control systems. They are suitable for use in remote control applications using infrared (IR), microwave or radio frequency (RF) transmitters.

The full custom IC implementation provides the best available combination of high security, low current consumption and small size in the industry. The encoders contains internal EEPROM for non-volatile data storage. The KEELOQ encoders will retain all information for several years, even when it is stored without supply voltage. Virtually no external components are required—all pull down resistors, oscillator components, and debouncing measures are included on the KEELOQ encoders.

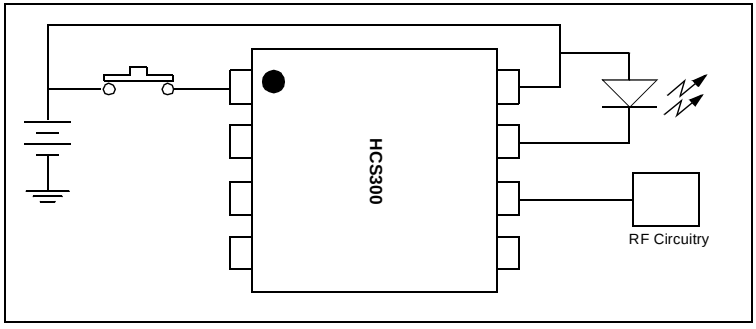



**Figure 3.1: Typical KEELOQ Transmitter Circuit**

The KEELOQ encoders can be used to implement an exceptionally simple remote control encoder. All that is required, in addition to the IC itself, is a circuit for transmitting the information (e.g., a radio frequency or infra-red transmitter), a battery, and a switch as shown in Figure 3.1. A single encoder can command a multifunction decoder to activate specific functions. The user would select the desired function through a number of buttons on the transmitter.

For a complete list of all the features on the various KEELOQ encoders and descriptions of their features, consult the appropriate data sheet included in the evaluation kit. A summary of encoder features and differences is given in Table 3.1.

# 3.2 Encoder Features

## 3.2.1 Encoder Synchronization

Every KEELOQ encoder has a 16-bit synchronization counter that is incremented each time the encoder is activated. The counter is encrypted and transmitted as part of a code hopping transmission. When a transmitter is learned by a decoder, the encoder's serial number, encryption key and synchronization information is stored in EEPROM. After this, it is very easy for a decoder to check whether a given transmission is a valid transmission or a repeated transmission transmitted by a code grabber by comparing the counter received with the stored value of the synchronization counter.

In addition, provision must be made for a user activating the transmitter while out of range of the decoder. KEELOQ decoders do this by allowing 2 synchronization windows. If the synchronization counter received is 1 to 16 above the stored counter, the decoder accepts the transmission as a valid transmission, updates the stored counter and activates the appropriate output. If the synchronization counter received is up to between 16 and 32k counts above the stored counter, the decoder temporarily stores the received counter and waits for a second transmission. The new counter is compared to the temporary counter and if they are consecutive, the decoder resynchronizes storing the latest counter and activates the appropriate output. Counter values outside of these windows, 32k to 64k counts above the stored counter value, are considered to be invalid and these transmissions are ignored.

## 3.2.2 Encoder Activation

The encoder inputs (S0 to S3) are used to activate the encoder. When any one or more of the encoder inputs is pulled HIGH, the encoder is activated. Part of the code transmitted is the function code. The function code mirrors the encoder inputs activated. The function code transmitted can be used by a multifunction decoder to activate specific functions. For example, S0 could be used to deactivate the alarm and unlock the car, S1 to open the trunk and when pressed together, a panic function can be activated.

## 3.2.3 Transmission Rates

Various modulation techniques are used to modulate data transmitted by the different encoders. KEELOQ encoders can use a pulse width modulation (PWM) technique, a variable pulse width modulation (VPWM) technique and a Manchester modulation technique. In addition to the selectable modulation technique available, the elemental period of the transmitted pulses are also selectable. The HCS300 for example has four transmission rates. These range from a basic pulse width of 400 µs with every word transmitted to a pulse width of 100 µs with 1/4 code words transmitted.

#### 3.2.3.1 Operating Voltage

The KEELOQ encoders have different operation voltages. The HCS300 for example will operate from 2 V to 6 V (typically one or two lithium cells). The HCS200 will operate from 3.5 V to 13 V (low cost 12 V lighter battery).

#### 3.2.3.2 Low Voltage Detection

The KEELOQ encoders all transmit a low voltage bit in each transmission. The bit is set when the encoder detects that the supply voltage has dropped below a set voltage. This allows the decoder to give an audio warning to the user when the battery needs replacement. For 2 V to 6 V encoders, the high trip point (two lithium cells) is approximately 4 V and the low voltage trip point (one lithium cell) is approximately 2.2 V. For the 13 V devices, the high and low trip points are about 8 V and 4 V respectively. Please consult the data sheets for more exact trip points.

#### 3.2.3.3 Counter Overflow

Part of the security of the KEELOQ device allows synchronization between the code hopping encoder and decoder to be transparent to the user. A 16-bit synchronization counter is incremented, encrypted, and transmitted each time the encoder is activated. The 16-bit length of the synchronization counter results in 18 years of use if the encoder is activated 10 times a day before the cycle begins to repeat. Should the system designer conclude that this is not adequate, overflow bits can be used to extend the cycle. The one of the overflow bits is cleared each time the counter wraps 0000. One overflow bit doubles the range of the synchronization counter and two overflow bits triple the range of the synchronization counter.

### 3.2.4 Auto-shutoff

An auto-shutoff function is available on the KEELOQ encoders. If enabled, the auto-shutoff function automatically stops the device from transmitting if a button is inadvertently pressed for a long period of time. This will prevent the encoder from draining the battery if a button gets pressed while in a pocket or purse. The time-out period is approximately 25 seconds.

**Table 3.1: Summary of KEELOQ Encoder Differences**

| Encoder | PWM | Manchester | VPWM | 13V | Overflow Bits | Function Inputs | LED |
|---|---|---|---|---|---|---|---|
| HCS200 | X | | | X | 0 | 3 | |
| HCS201 | X | | | X | | 3 | |
| HCS300 | X | | | | | 3 | |
| HCS301 | X | | | X | 2 | 4 | X |
| HCS320 | X | | | X | 2 | 4 | X |
| HCS360 | X | X | | | 1 | 4 | X |
| HCS361 | X | | X | | 1 | 4 | X |

**NOTES:**

# Chapter 4. Demonstration Transmitters

The demonstration transmitters in the evaluation kit allow any of the KEELOQ encoders to be used in the socket as shown in Figure 4.1 below. The four buttons on the demonstration transmitters are connected to each of the inputs on the encoder (S0 through S3). This allows the user to activate any input or combination of inputs on the encoder. This allows all of the possible function codes to be transmitted.

Although the transmitter boards are primarily intended for use with the rest of the kit, the data stream is directly accessible via a pair of test points on the transmitter board. Test point E is the PWM output of the encoder and can be used to monitor the output of the encoder, if required. Test point T is the input to the RF section of the transmitter. Normally a link is installed between the two test points routing the encoder's output directly to the RF section of the transmitter. The RF oscillator uses a surface acoustic wave (SAW) resonator as a frequency stabilizing element and oscillates around 433.9 MHz.

The connector (J1) at the foot of the transmitter enables the transmitter to be connected to the programmer included in the evaluation kit (Figure 4.1). This allows the encoder on the demonstration transmitter to be reprogrammed by the user.

**Note:** Production transmitters only need four lines to allow programming of the encoder on the transmitter. The 16-pin connector is only used to connect the transmitter to the programmer board.

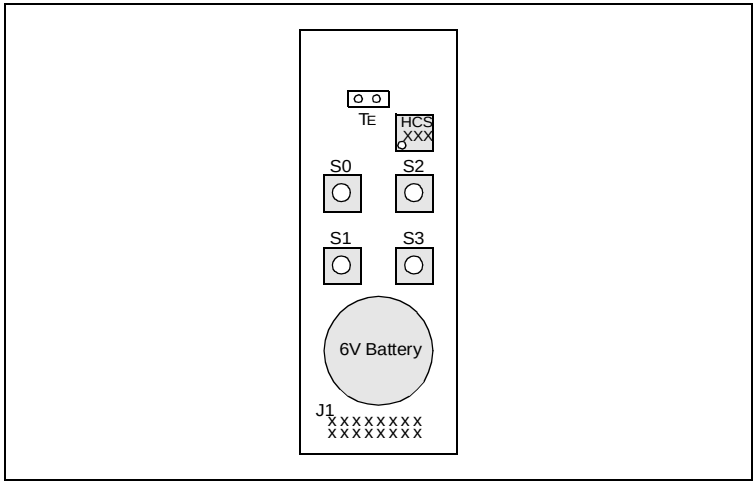



**Figure 4.1: KEELOQ Demonstration Transmitter**

**NOTES:**

# Chapter 5. KEELOQ Decoder

## 5.1 Key Features

- Demonstrates the HCS512 decoder
- Demonstrates the normal, secure learn and simple software decoders
- Compatible with Microchip HCS200, HCS201, HCS300, HCS301, HCS320, HCS360, and HCS361 encoders
- Automatic baud rate detection
- Four function outputs, up to 15 output combinations
- Up to six learnable transmitters
- RC Oscillator

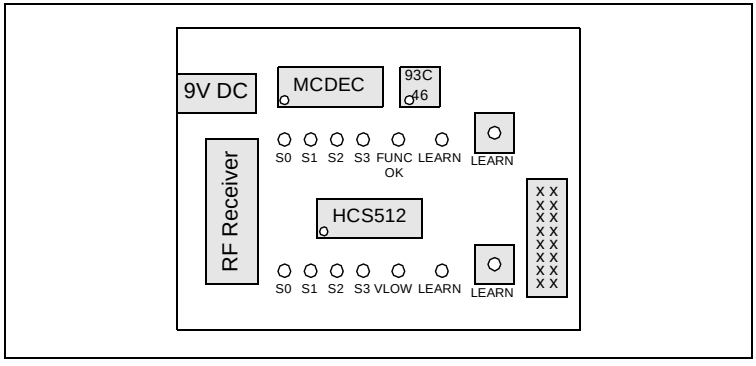



**Figure 5.1: KEELOQ Decoder Demonstration Board**

## 5.2 Typical Applications

- Burglar alarm systems
- Remote control
- Central locking systems
- Gate and garage door openers
- Vehicle immobilizers
- Identity tokens
- High security access control

## 5.3 General Information

The decoder demonstration board demonstrates the HCS512 and the software decoders. The decoder demonstration board has two sections. The first section is on the upper half of the board and can be used to demonstrate the features of any of the software decoders included in the evaluation kit. The lower half of the board demonstrates the HCS512 decoder. The power supply, brown out detector, and RF receiver circuitry are shared by the two sections of the board.

All the decoders are compatible with and are able to learn all of the KEELOQ encoders currently available. These are the HCS200, HCS201, HCS300, HCS301, HCS320, HCS360 and HCS361 encoders.

## 5.4 Software Decoders

There are three software decoders that can be used in this portion of the board. The biggest difference between the decoders is that different learn methods are used in each of them as described below. A disk containing the source code of the different decoders and a detailed application note describing the source code have been included in the evaluation kit.

The Normal Decoder (MCDEC) generates keys using the serial number as a source and the decryption algorithm as the key generation algorithm.

The Secure Learn Decoder (MCSLRN) uses a seed transmitted by the decoder to generate a key and either the XOR algorithm or the decryption algorithm (selectable in the source code by the application note) as the key generation algorithm.

The Simple Decoder has a common key for all encoders which is hard coded in the decoder. For this reason, key generation is not necessary. Learn only requires a single transmission from the encoder being learned to transfer the encoder's serial number and synchronization information.

The manufacturer's key on the software decoder samples is $0123456789ABCDEF_{16}$. If the user chooses to use the application notes as a starting point for a design, the manufacturer's key can be changed as described in the appropriate application note.

## 5.5 HCS512 Decoder

The HCS512 is a fully functional KEELOQ decoder. The HCS512 can be used as a stand-alone decoder with the S0:S3 outputs being connected directly the system outputs. The HCS512 can also be used in conjunction with another microcontroller if the synchronous outputs (CLOCK and DATA) are monitored by another microcontroller.

The HCS512 also has a sleep mode which can be used for low power applications.

## 5.6 Output Activation

S0:S3—These outputs mirror the buttons pressed on a learned transmitter.

LEARN—The learn output is used to give the user feedback on a learn sequence. During normal operation, the LEARN LED flashes briefly whenever a KEELOQ transmission is received.

FUNC OK—The FUNC OK LED is activated when the decoder receives a transmission with the same function code as the one received when the decoder was learned.

VLOW—The output is activated when the VLOW bit is set in a received transmission. A KEELOQ encoder will set this bit when the battery supply voltage drops below the point set when the encoder was programmed.

**Table 5.1: Decoder Summary**

| Decoder | S0:S3 | Learn | FUNC OK | VLOW | Maximum Transmitters |
|---|---|---|---|---|---|
| MCSIMDEC | X | X | | | 15 |
| MCDEC | X | X | X | | 6 |
| MCSLRN | X | X | X | | 6 |
| HCS512 | X | X | | X | 4 |

## 5.7 Learning New Transmitters

Learning is a feature of both the software decoders and the HCS512 that allows the addition of new transmitters to the system without the need to reprogram the system. During the learning process, the decoder identifies the transmitter and stores its parameters (key and synchronization information) in EEPROM for future use. If the transmitter is activated again, the decoder will recognize the transmitter and respond to it normally.

The decoder's learning capabilities simplify replacement of lost transmitters. When a transmitter is lost, the user can "teach" the decoder the key of a new transmitter bought off the shelf. The different decoders have different maximum numbers of transmitters. For example, the MCDEC decoder can learn up to six transmitters and the HCS512 can learn up to four transmitters. When a transmitter is lost, it is advisable to erase and relearn all existing transmitters to ensure that the lost transmitter is denied access to the system.

Learning a transmitter by a decoder is a two-phase process. During the learn process, a key is generated by the decoder. The key is stored with the serial number and synchronization information after the key has been verified.

The key generation process has three inputs. The first is the source of the key generation. The source can be the encoder's serial number (normal learn) or the encoder's seed (secure learn). The next input is the key generation algorithm. There are two algorithms commonly used by KEELOQ products. The first uses the decryption algorithm and the second is an XOR algorithm. The third input to the system is a manufacturer's key. The manufacturer's key tailors the key generation algorithm to a specific manufacturer. This customizing of the key generation algorithm means competitors cannot clone transmitters for a system.

With the exception of the Simple Decoder, two transmissions are needed by the decoder during learn; one is used to generated a key and the second, to validate the generated key. If the user uses the serial number as the key generation source, then both transmissions will be normal hopping code transmissions. If the user chooses to use secure learn (seed as the key generation source), the first transmission should be a hopping code transmission, and the second transmission a seed transmission. The HCS360 and HCS361 encoders are ideally suited for secure learn. These encoders transmit the seed if S0 and S1 are activated for longer than 3 seconds. This means that secure learn can be performed with a single extended press of a button assuming the button is tied to S0 and S1.

The evaluation kit and current KEELOQ production programming systems have been designed so that the key generation and programming is transparent to the user.

### 5.7.1 Learning Procedure

Learning a transmitter on the MCDEC, MCSLRN, and HCS512 decoders is accomplished as follows:

1. Press and release the appropriate decoder's LEARN button. The LEARN LED will turn on to indicate that the decoder has entered Learn mode.
2. Press transmitter button. The LEARN LED will turn off, indicating a transmission has been received.
3. Press transmitter a second time. The LEARN LED will flash to indicate that the transmitter was learned successfully.

**Note:** The second transmission must be a SEED transmission when secure learn is used.

4. Repeat steps 1-3 to learn up to the maximum number of transmitters. Additional transmitters will overwrite transmitters already in the system.
5. Learning will be terminated if two non-sequential codes are received or if two acceptable codes were not received within about 30 seconds. An unsuccessful learning attempt will be indicated by the LEARN LED turning on for 1 second.

#### 5.7.1.1 MCSIMDEC Learning

The simple decoder is a special case of key generation. All encoders and decoders share a common key, the manufacturer's key. The system security using this key generation method is diminished. The learn procedure flows as follows:

1. Press and release the LEARN button. The LEARN LED will turn on while the button is pressed and extinguish when the button is released.
2. Press the transmitter button.
3. The LEARN LED will turn on for a second if the learn is successful. If the transmission is not acceptable or a transmission is not received within 30 seconds, the decoder will return to normal operation.

### 5.7.2 Transmitter Erasing

Erasing of all the transmitters is accomplished by pressing and holding the LEARN button for 8 seconds. The LED will turn off at the end of the 8 seconds to indicate that the transmitters were erased.

**NOTES:**

# Chapter 6. KEELOQ Programmer

## 6.1 Features

- Programming of HCS200, HCS201, HCS300, HCS301, HCS320, HCS360, HCS361 encoders
- Programming of HCS500, HCS512, and HCS515 decoders
- Programming of demonstration transmitters
- Reception and display of code hopping transmissions
- User friendly Windows-based user interface
- Configuration File to save system setup

### 6.1.1 Programming Setup

Programming is a two-phase process. First, the system needs to be set up. This involves the selection of an encoder and decoder. These can be selected from the "System Setup" dialog box in the "Setup" menu (see Figure 6.1). After the encoder/decoder pair have been selected, the user can exit by clicking on the **OK** push-button.

The user should then check the key generation options by selecting "Program Decoder" from the "Program" menu.

The manufacturer's code can also be changed in the "Manufacturer's Code" dialog, selected in the "Setup" menu.

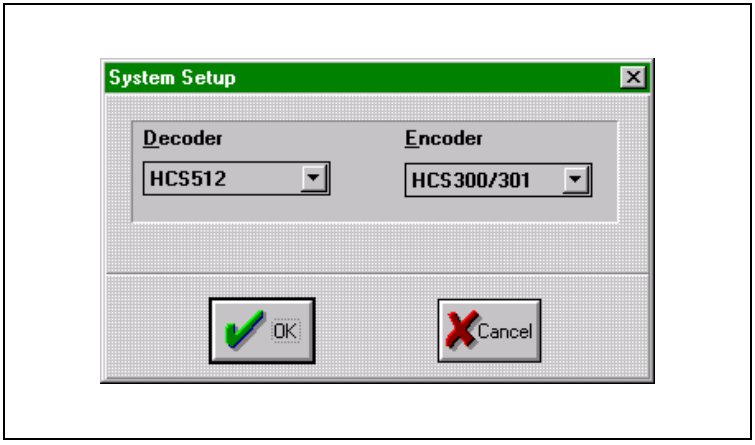



**Figure 6.1: System Setup Dialog**

## 6.1.2 Decoder Programming

### 6.1.2.1 HCS512

Of the decoders available in the evaluation kit, only the HCS512 needs to be programmed. If the decoder selected is the HCS512, the "Program HCS512" dialog box will allow the user to select the key generation source and algorithm. The HCS512 should be connected to the programmer board as shown in Figure 6.2 using the ribbon cable supplied.

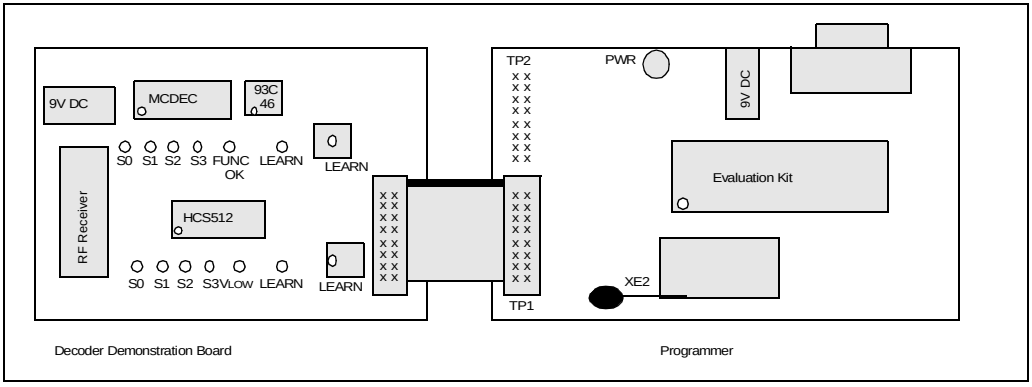



**Figure 6.2: Programming the HCS512**

### 6.1.2.2 HCS500 and HCS515 Programming

It is possible to use the evaluation kit to reprogram HCS500 and HCS515 decoders. A connection from the evaluation kit (TP1) to the decoder board will have to be made. The pin connection is given in Appendix B. When attempting to program the devices ensure that the parts are powered up.

### 6.1.2.3 Software Decoders

The software encoders all have the manufacturer's code stored in ROM and don't need to be programmed. The manufacturer's code in all of the software decoders is 01234567-89ABCDEF$_{16}$. The manufacturer's code can be changed if the user decides to use one of the software decoders as a starting point for the development of a custom decoder as described in the appropriate application note.

If the decoder selected is the Secure Learn decoder (MCSLRN), the user does have the option of selecting the code generation algorithm. This can be changed in the source code of the secure learn decoder (AN652). The algorithm selected for the samples in the evaluation kit is the XOR algorithm and should be setup by selecting "Program Decoder" from the programmer.

### 6.1.3 Encoder & Transmitter Programming

Having selected an encoder, a decoder, and the key generation options where applicable, the user can program encoders. The programming can be done as follows. From the Program menu, select the “Program Encoder” option. This will bring up a dialog box. The dialog box contains system information such as the manufacturer’s code and decoder type. The encoder’s user selectable options can also be changed.

After checking the setup and encoder options, the user should insert the encoder to be programmed into half of the ZIF (XE2) socket as shown in Figure 6.3 if the user is programming an encoder. If the user is programming a transmitter, the user should connect the transmitter to the programmer as shown in Figure 6.4.

### 6.1.4 Advanced Encoder Options

As the user may have noticed, not all options on every encoder are available on the normal dialog boxes (e.g. Discrimination values). These are typically options, that when changed, will result in encoders being programmed with data that will prevent them being learned by the decoder's shipped with the evaluation kit. The user can enable the advanced options by selecting *Setup>Advanced Options*. When the Program dialog box is next brought up (*Program>Encoder*), the user will be able to set / clear all of the options. This option should only be enabled by a user familiar with KEELOQ encoders & decoders.

### 6.1.5 Configuration File

The system setup can be saved once the system has been setup. This can be done using the "Save Setup" or "Save As…" in the "File" menu. A configuration file can be loaded using the "Load Setup" option in the "File" menu.

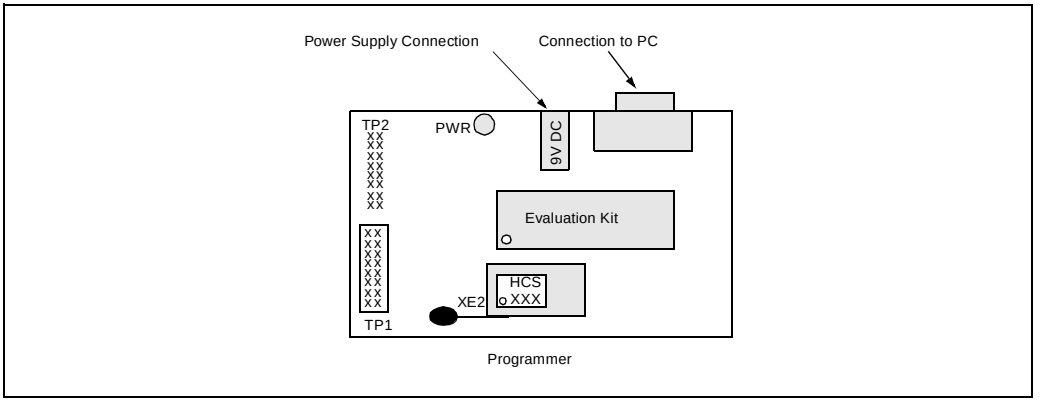



**Figure 6.3: Programming an Encoder DIP**

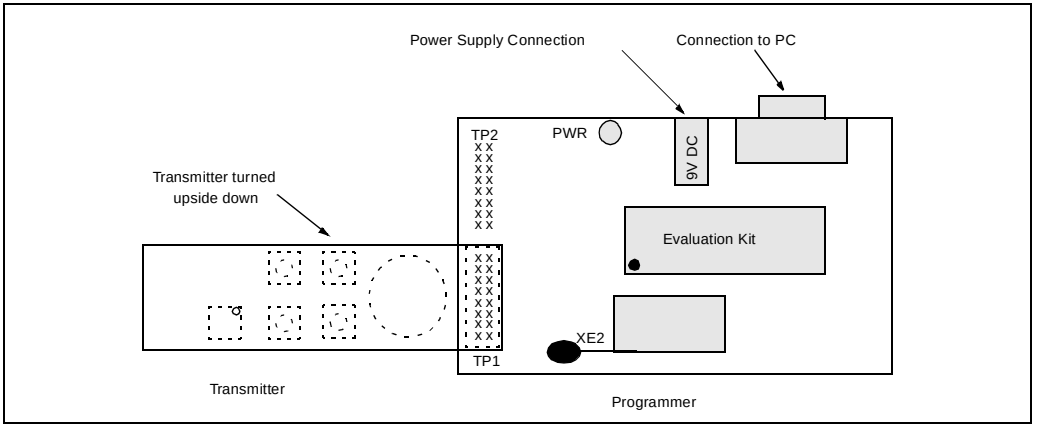



**Figure 6.4: Programming the Demonstration Transmitters**

# Chapter 7. Displaying KEELOQ Transmissions

## 7.1 Description

The programmer can work in two modes. In the first mode, the programmer is used to program KEELOQ devices. In the second mode, the programmer can be used to receive and display KEELOQ transmissions on a PC.

In the mode which allows a PC to display the hop codes received, the programmer needs to use the RF receiver on the decoder board supplied. To do this, the two boards need to be connected as described in Figure 7.1 with the 16-wire ribbon cable supplied.

## 7.2 Hardware Connection

The programmer uses the RF module present on the decoder demonstration board to capture RF transmissions.

To connect the programmer and decoder:

1. Disconnect power from both the decoder and programmer boards.
2. Check that the ZIF socket on the programmer is empty (no encoders present).
3. Connect the 16-way ribbon cable as shown in Figure 7.1.
4. Connect the RS-232 cable supplied between the programmer and a free serial port on the PC running the evaluation software.
5. Plug the power supplied with the evaluation kit into the programmer board.

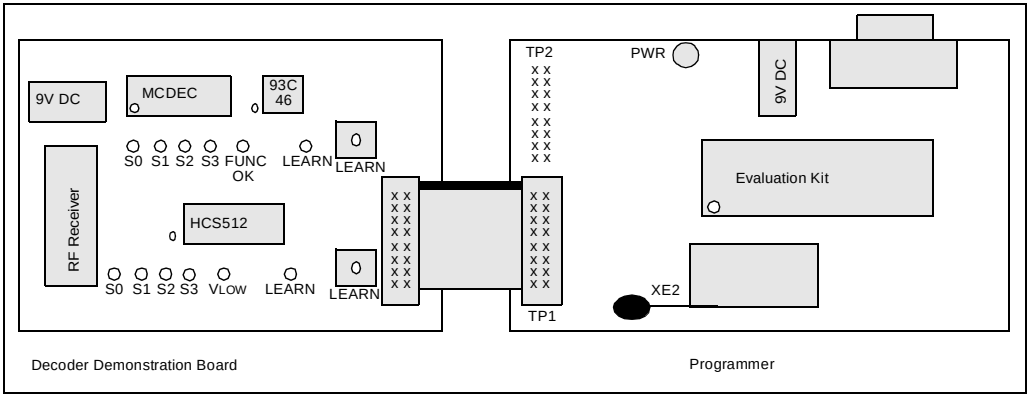



**Figure 7.1: PC Receiver Hardware Setup**

## 7.3 Receiving KEELOQ Transmissions

Connect the programmer and decoder as described in the previous section, "Hardware Connection." Selecting "Display Hopping Codes" in the Display menu will bring up a dialog box entitled "KEELOQ Transmissions." Activating a transmitter near the decoder board will result in the most significant bit of the transmission received being on the left-hand side (See Figure 7.2).

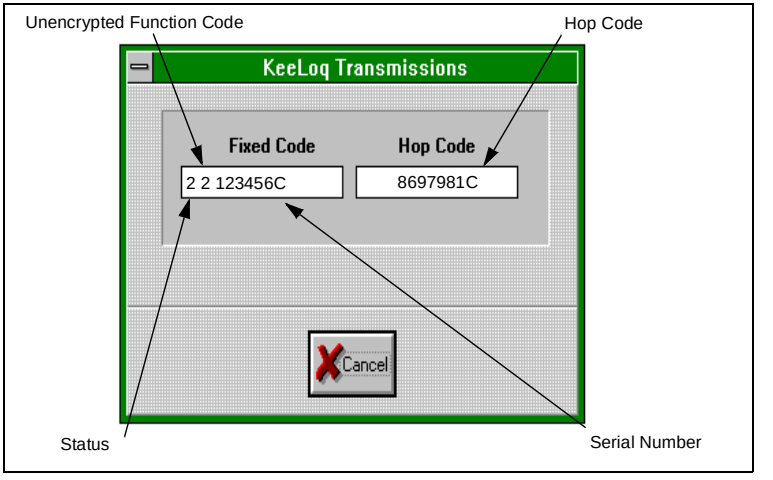



**Figure 7.2: KEELOQ Transmissions Dialog Box**

In the example shown in Figure 7.2,

- Status bits are 1 and 0 respectively
- The function code transmitted is 2 ($S_2$ activated on the transmitter)
- The serial number of the transmitter is $123456C_{16}$
- The hopping code received is $8697981C_{16}$

## 7.4 Troubleshooting

### PROBLEM:

If the KEELOQ software is unable to initialize the programmer board, the software will display an error message.

### SOLUTIONS:

1. Check that the RS-232 cable between the PC and programmer is in place.
2. Check that the programmer is connected to the power supply.
3. Check that the correct serial port has been selected.
4. Reset the programmer board.

### PROBLEM:

If no transmissions are received:

### SOLUTIONS:

1. Check that the ZIF socket (XE2) on the programmer is empty.
2. Check that the connection between the decoder and programmer is correct.
3. Check that the serial cable between the programmer and PC is in place.
4. Check that the RF ENABLE (J3) link on the decoder board is in place.
5. Check that the link JP1 on the transmitter is in place.

**NOTES:**

# Appendix A. Schematic Diagrams

**Figure A.1: Encoder Schematic**

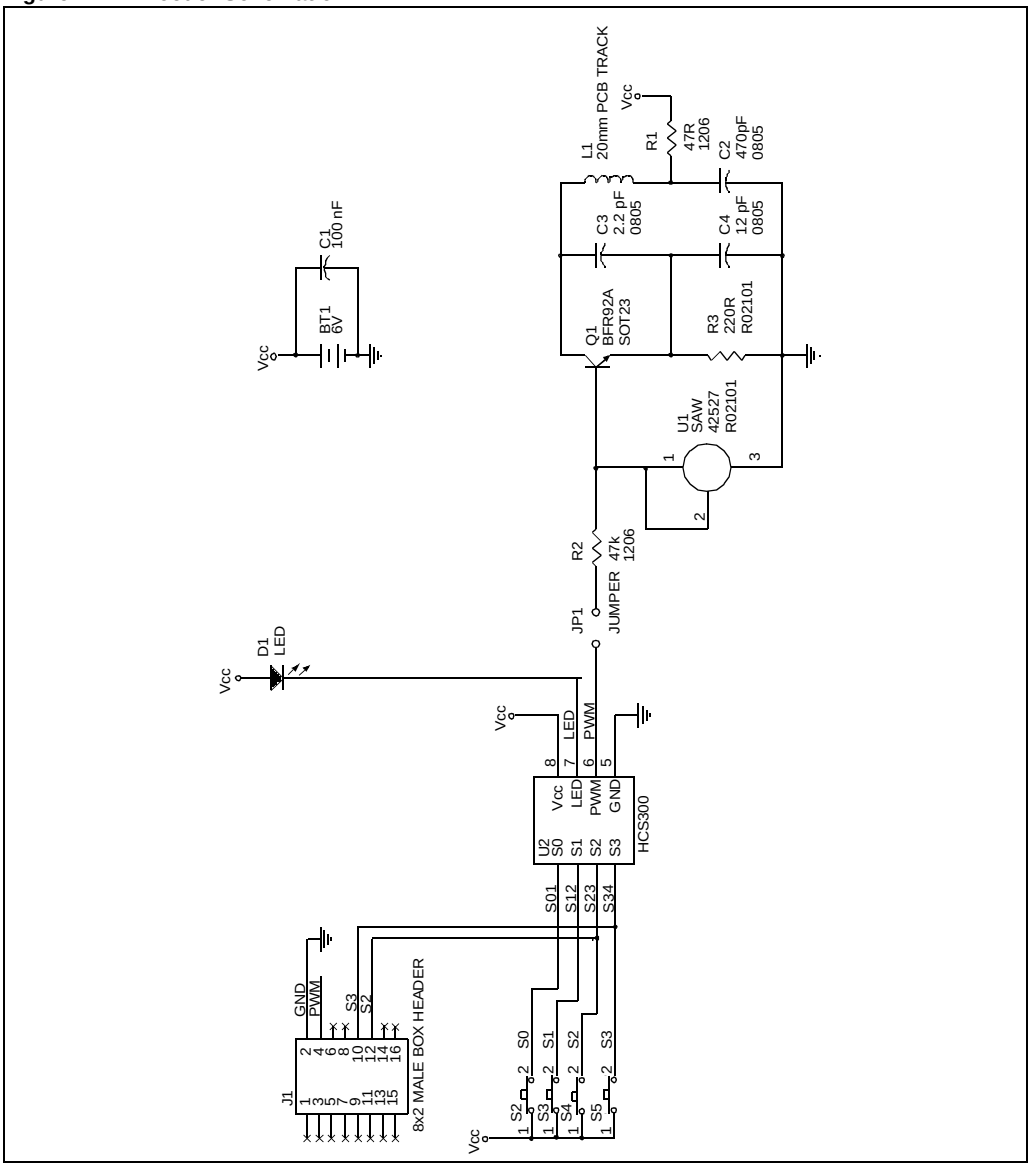


**Figure A.2: Programmer Schematic**

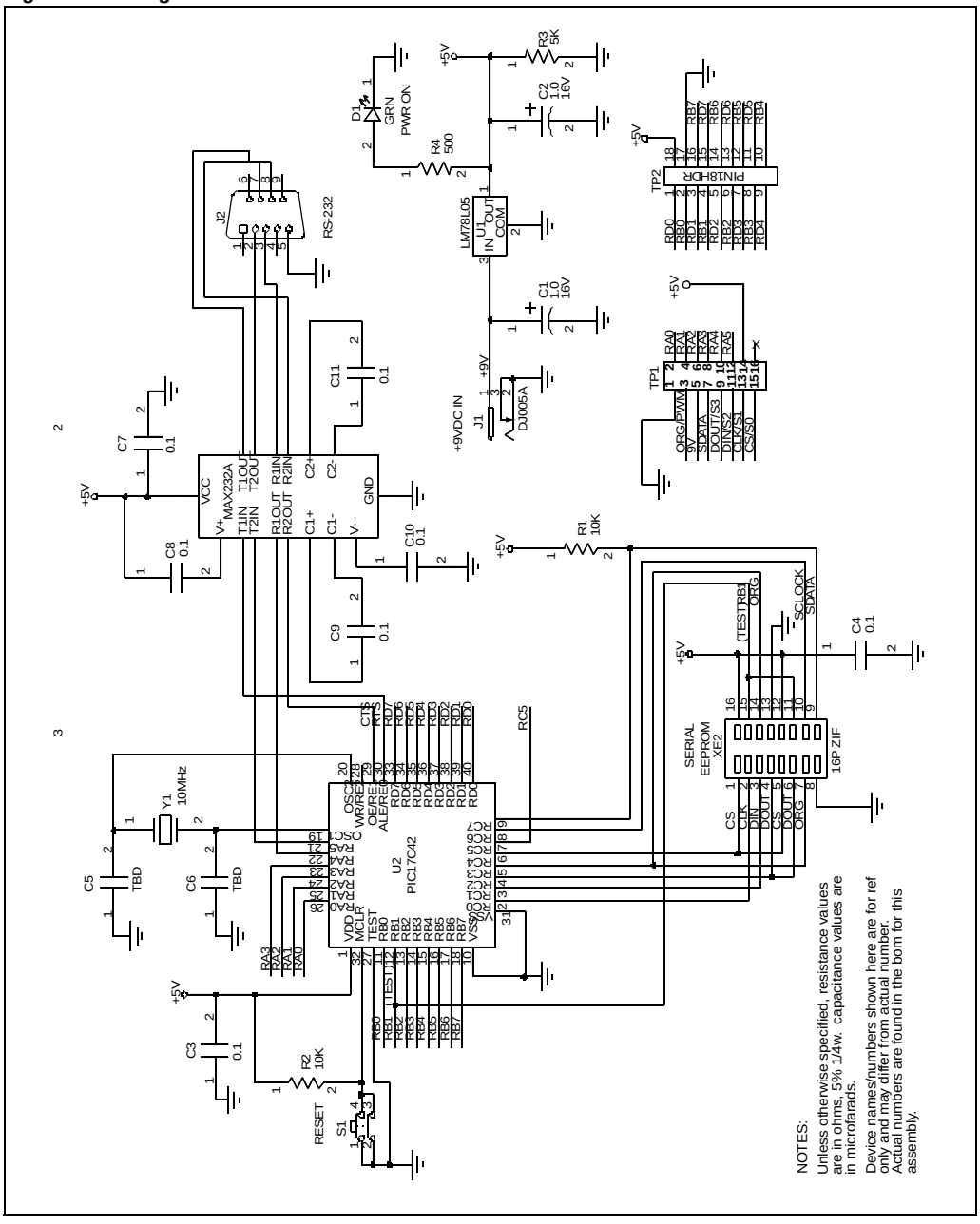
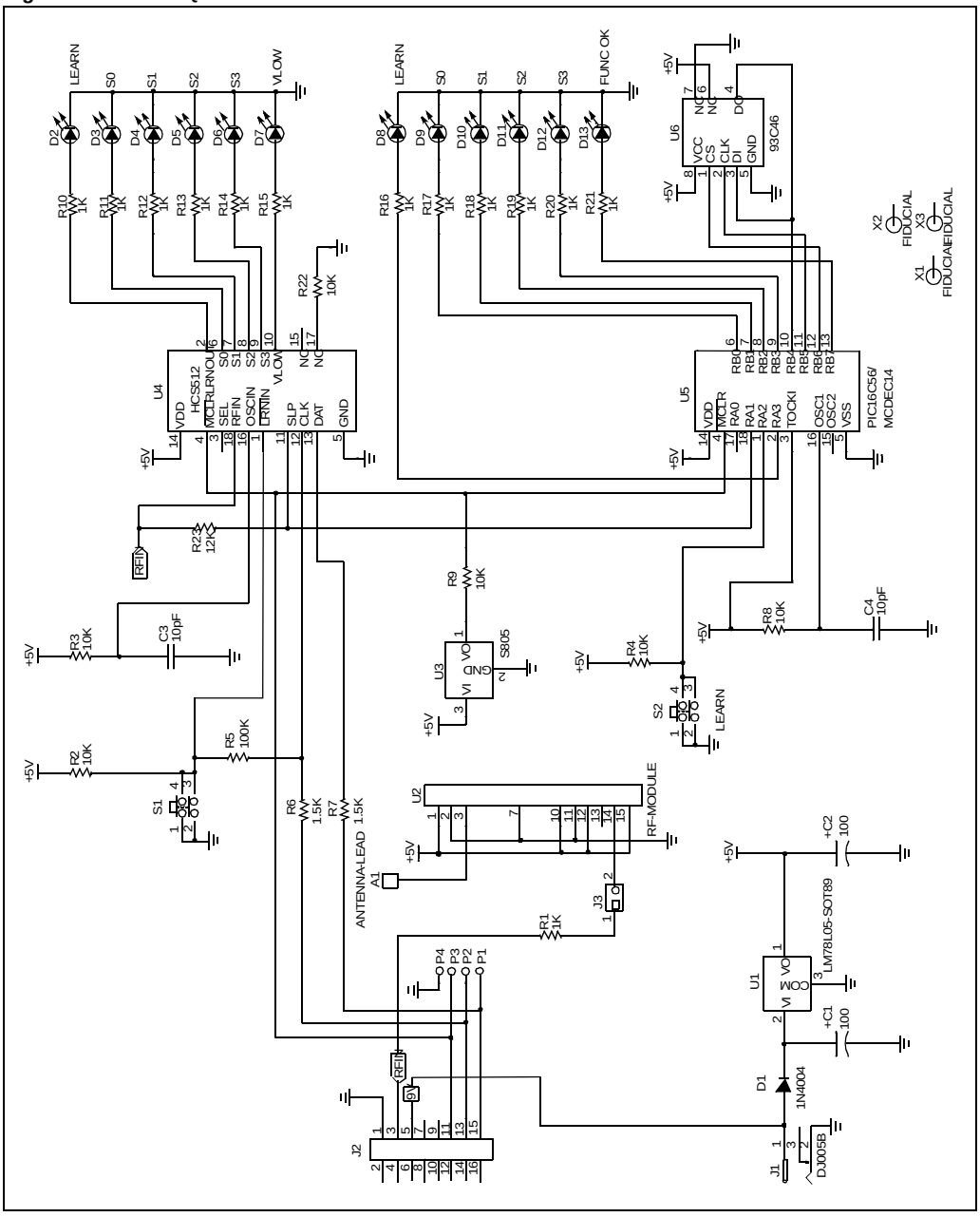


**Figure A.3: KEELOQ Decoder Schematic**



**NOTES:**

# Appendix B. In-Circuit Programming

The KEELOQ Evaluation Kit programmer can be used to program pre-production encoders and decoders in their final circuits as a means of validating the design. The connections from TP1 on the programmer board to the various pins on the various encoders and decoders are given below. The schematic diagrams in the appendix give an example of how the programming pads should be connected to the encoder or decoder under test. Once TP1 has been connected to the appropriate pins on the encoder or decoder, programming can be initiated by the Evaluation Kit software as normal.

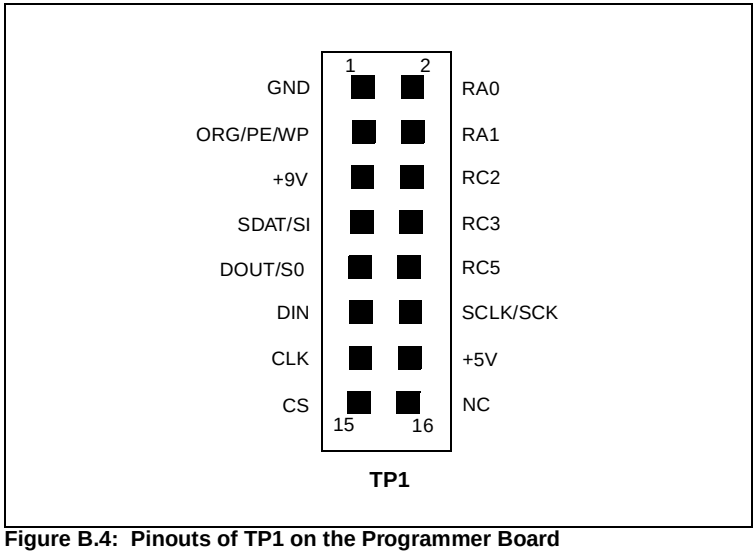



**Figure B.4: Pinouts of TP1 on the Programmer Board**

## B.0.1 HCS200/HCS201/HCS320 Connection

| Description | TP1 | Encoder Pin |
|---|---|---|
| Ground | 1 (GND) | 5 (GND) |
| Clock | 11 (DIN) | 3 (S2) |
| Data | 3 ORG/PE/WP) | 6 (PWM) |
| Power | 14 (+5V) | 8 ($V_{DD}$) |

### B.0.2 HCS300/HCS301/HCS360/HCS361 Connection

| Description | TP1 | Encoder Pin |
|---|---|---|
| Ground | 1 (GND) | 5 (GND) |
| Clock | 9 (DOUT/S0) | 4 (S3) |
| Data | 3 (ORG/PE/WP) | 6 (PWM) |
| Power | 14 (+5V) | 8 ($V_{DD}$) |

### B.0.3 HCS500 Connection

| Description | TP1 | Decoder Pin |
|---|---|---|
| Ground | 1 (GND) | 8 (GND) |
| Clock | 13 (CLK) | 6 (CLK) |
| Data | 15 (CS) | 5 (DATA) |
| Power | 14 (+5V) | 1 ($V_{DD}$) |

### B.0.4 HCS512 Connection

| Description | TP1 | Decoder Pin |
|---|---|---|
| Ground | 1 (GND) | 5 (GND) |
| Clock | 13 (CLK) | 12 (CLK) |
| Data | 15 (CS) | 13 (DATA) |
| Master Clear (Reset) | 11 (DIN) | 4 (MCLR) |
| Power | 14 (+5V) | 14 ($V_{DD}$) |

### B.0.5 HCS515 Connection

| Description | TP1 | Decoder Pin |
|---|---|---|
| Ground | 1 (GND) | 12 (GND) |
| Clock | 13 (CLK) | 10 (CLK) |
| Data | 15 (CS) | 9 (DATA) |
| Power | 14 (+5V) | 3 ($V_{DD}$) |

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Arizona Microchip Technology GmbH
Gustav-Heinemann-Ring 125
D-81739 München, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

**Italy**
Arizona Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

**United Kingdom**
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
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